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Eighteenth day of March 2005

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An object orientation data system

Field of the invention

The present invention relates to systems, methods and apparatus which gather and process data concerning the spatial orientation of an object.

Background of the invention

The advent and proliferation of gaming technology in the past few years has led to a widening of the acceptance video/console gaming systems. Such systems have thus far had limited ability to collect spatial orientation data as game input, due to the high cost of manufacture of interfaces which are physically capable of collecting natural 3D movement input by viewers. By far the most common form of spatial direction input has been with the small joystick attached to the standard game controllers like those bundled with Xbox and Play Station 2 consoles.

One reason for this is that it is expected that the gathering of orientation data by known remote spatial sensing systems requires a more processing power than is practically available in current and near future game consoles, while the alternative approach (purpose built devices for 3D spatial data collection such as joy sticks, steering wheels etc are very expensive, highly complex, game specific, and cannot be manufactured with appropriate robustness within the price range of the majority of the target market..

It is believed that if orientation data systems can be provided which are relatively simple, relatively inexpensive and robust, that such systems when programmed for interaction with gaming consoles, may give to users of such consoles a greater degree of enjoyment and interaction, than current systems.

The present invention seeks to provide an object orientation data system, method and apparatus, which will ameliorate, at least in part, at least one of the drawbacks of complex data orientation systems.

The present invention also seeks to provide an alternative solution.

The applicant does not concede that the prior art discussed in the specification forms part of the common general knowledge in the art at the priority date of this application.

Summary of the invention

The present invention provides an object orientation data gathering system which can have: at least one sensing means to detect and receive a visible light signal; a pattern or indicia recognition processing means which receives signals from said at least one sensing means; at least one light means corresponding to a respective one of said sensing means which generates, reflects or transmits visible light located remotely from but in line of sight to said sensing means; wherein said light means causes a pattern, indicia, colour or shape to be visible by said sensing means, said pattern, indicia, colour or shape which is sensed by said sensing means being caused to change when the relative angle between said sensing means and said light means is changed, whereby the change in pattern, indicia, colour or shape is processed by said processing means to identify the change in angle.

The change in angle can then be communicated to a CPU for use in processing the change in orientation between the sensing means and the light means.

The sensing means can be at an unmoving reference point.

The sensing means cannot change its orientation relative to earth.

The light means can be positioned on an object the orientation of which is being sensed relative to said sensing means' orientation.

The light means can be at an unmoving reference point.

The light means can change its orientation relative to earth.

The sensing means can be positioned on an object the orientation of which is being sensed relative to said light means' orientation.

The light means can produce a light signal by means of reflected and or transmitted light.

The light means can utilise one or a combination of one or more of the following: a holographic system, a lenticular system, a polarised filter system. The holographic system, the lenticular system or the polarised filter system can each have one or a sequence of more than one image associated therewith.

The light means can include one or more lenticular systems.

The system can include more than one lenticular systems, each system having an image sequence whereby a lenticular image is viewable in said respective lenticular system when said respective lenticular system is viewed from different orientation.

The system can further include columnar lenticules which are utilised in said lenticular systems. Alternatively, the system can include an array or matrix of discrete lenses on said lenticular systems.

Multiple lenticular systems can be used with the columnar direction of the lenticules of each respective lenticular system being at a different angle to each of the other lenticular systems.

The light means can be made up of a plurality of lenticular systems, with each lenticular system being located in substantially the same planar orientation.

The light means can be made up of a plurality of lenticular systems, with one or more lenticular system being located in a different planar orientation to the rest of the lenticular systems.

The system can include two lenticular systems which are used with the angular spacing between the columnar lenticules on one panel relative to the other panel is approximately 90°.

Three lenticular systems can be used with the angular spacing between the columnar lenticules between respective lenticular systems is 120°.

Four lenticular systems can be used with the angular spacing between the columnar lenticules of a first and a second lenticular system is approximately 90°.

The angular spacing between a first set of first and second lenticular systems and the second set of first and second lenticular systems can be approximately 45°.

The light means can be located within a distinctively shaped panel or border to form a target.

The light means can be such that when the light means is viewed from different angles, then an exhibited pattern will change to a different pattern, or an exhibited indicia will change to a different indicia, or an exhibited colour will change to a different colour, or an exhibited shape will change to a different shape.

The light means can be such that when the light means is viewed from different angles, then an exhibited pattern will change to one or more than one of: an indicia, colour or shape; or an exhibited indicia will change to one or more than one of: a pattern, colour, shape; or an exhibited colour will change to one or more than one of: a pattern, indicia, shape; or an exhibited shape will change to one or more than one of: a pattern, indicia, colour.

The indicia can include letters, numbers, symbols or any appropriate machine recognisable image.

The sensing means can be a digital camera.

There is preferably only one sensing means and only one light means.

The processing means can operate to identify the angular orientation by one or more of the following: comparing the light or images sensed from said light means to a predefined table to determine orientation; processing by means of logical progression through an algorithm.

Means can be provided in said processing means, and said sensing means to calibrate a starting orientation of said light means to said sensing means.

The present invention also provides a gaming system such as a computer based, console based, arcade based gaming system, wherein a system is utilised to provide orientation data to a control system for said gaming system as described above.

Through out the specification and claims the words "lenticular" and "lenticule", and words or expressions derived therefrom, have a meaning which includes that the lens elements are not limited to a cylindrical columnar or hemi-cylindrical columnar lens. Unless expressly indicated the lens can include other shape lenses, such a rectangular prism, triangular prisms and can further include hemi-spherical; toroidal (as in the case of FRESNEL lenses); a matrix or array of a multiplicity of discrete lenses, whether they be concave or convex, or the lenses are square, rectangular, polygonal, pyramidal etc.

Brief description of the drawings

An embodiment or embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is schematic representation of a panel of lenticular systems;

Figure 2 illustrates the possible lenticular images able to be displayed by the lenticular systems of figure 1;

Figure 3 illustrates the panel of figure 1 displaying lenticular images which would be viewable when the panel of figure 1 is in a plane perpendicular to the direction to a camera;

Figure 4, being made up of figures 4A, 4B and 4C, illustrates the panel of figure 1 in three orientations displaying lenticular images which would be viewable when the panel of figure 1 is rotated clockwise and anticlockwise around a vertical axis from a plane perpendicular to the direction to a camera;

Figure 5, being made up of figures 5A, 5B and 5C, illustrates the panel of figure 1 in three orientations displaying lenticular images which would be viewable when the panel of figure 1 is rotated in two directions around a horizontal axis from a plane perpendicular to the direction to a camera;

Figure 6, being made up of figures 6A, 6B and 6C, illustrates the panel of figure 1 in three orientations displaying lenticular images which would be viewable when the panel of figure 1 is rotated in two directions around an inclined axis from a plane perpendicular to the direction to a camera;

Figure 7, being made up of figures 7A,7B and 7C, illustrates the panel of figure 1 in three orientations displaying lenticular images which would be viewable when the panel of figure 1 is rotated in two direction around an inclined axis (which is at 90° to the axis of rotation in figure 7) from a plane perpendicular to the direction to a camera;

Figure 8 illustrates the panel of figure 1 showing the orientations of figures 4 to 7;

Figure 9 illustrates schematically the use of the panel of figure 1 on a game controller and providing a signal to a digital camera;

Figure 10 illustrates a panel having a composite of twelve lenticular systems, showing only the orientation of the columnar lenticules in each of the twelve lenticular systems or segments;

Figure 11 illustrates the shapes or symbols that the panel of figure 10 may produce when rotated about the axes of rotation used in figures 4 to 7;

Figure 12 illustrates the shapes or symbol of figure 11, with additional grey colouring where other segments are in a transitional orientation;

Figure 13 illustrates a flow chart of the steps in the processing of the orientation data produced by the panels; and

Figure 14 illustrates an unambiguously shaped panel or target, similar to the panel of figure 1, where three lenticular systems are utilised.

Detailed description of the embodiment or embodiments

While the following description of a preferred embodiment will be directed to a system useable with a game controller, it will be understood that the invention is equally applicable to other diverse fields such as robotics, vehicular crash testing, materials handling systems and any other system requiring orientation data.

Illustrated in figure 1 is a panel 10 having four lenticular systems 12, 14, 16, and 18. Each of the lenticular systems has a screen or layer of columnar lenticules overlying a plurality of lenticular images which form a lenticular image sequence. The number of lenticular images selected will be a function of the angular accuracy desired from the orientation data system. For the sake of explanation, the lenticular image sequence of each lenticular system 12, 14, 16 and 18 will be referred to as each having five lenticular images, with each lenticular image being viewable when the lenticular system is rotated about an axis parallel to the direction of the columnar lenticules. A different image is viewable for every 9.4° of rotation, where the angle of rotation between the start of the first and lenticular images and the end of the fifth lenticular image is 47°.

As is illustrated in figure 1, the lenticular system 12 is oriented, by means of the direction of the columnar lenticules, at 0° on a Cartesian plane (or East to West, West to East on a compass face), while lenticular system 14 is at 90° on a Cartesian plane (or North to South, South to North on a compass face), lenticular system 16 is oriented at 135° or 315° on a Cartesian plane (North West to South East, South East to North West on a compass face) and finally lenticular system 18 is oriented at 45° or 225° (North East to South West, South West to North East on a compass face).

In figure 2, the lenticular systems 12, 14 and 18 are each illustrated as having five distinct images, in this case images of the numerals 1, 2, 3, 4, and 5. Whereas the lenticular system 16 is illustrated as having five distinct images as well, however these images are of the letters A, B, C, D, E. If desired each respective lenticular system can have a different image sequence.

As is illustrated in figure 3, the lenticular systems 12, 14, 16 and 18 are designed so that when viewed perpendicular to the eye of a human or the lens of a digital camera, the central lenticular image is visible of each lenticular system's lenticular image sequence. In this case, for the lenticular systems 12, 14 and 18 the numeral 3 is visible, while for the lenticular system 16, the letter C is visible.

As illustrated in figure 4, there are three sub-figures 4A, 4B and 4C. Sub-figure 4A illustrates the panel 10 theoretically rotated 4.7° around an axis parallel to the direction of lenticular columns of lenticular system 14 whereby the side of the panel 10 with lenticular system 14 is rotated out of the page and the opposite side rotated into the page. As can be seen from sub-figure 4A the lenticular system 14 now displays a numeral 2 (and will continue to do so for a further 9.4° of rotation in the same direction), whereas in sub-figure 4C, which is rotated 4.7° in the opposite direction from 0°, the numeral 4 is visible (and will continue to do so for a further 9.4° of rotation in the same direction). The central sub-figure 4B illustrates the panel 10 at 0° to the viewer, that is where the panel 10 is in a plane perpendicular or normal to a line to the camera or eye or viewer.

The lenticular systems 16 and 18, due to the angular orientation of the lenticular columns, may have their displayed images changed slightly due to transitional orientation, however, it is expected that the lenticular system 12 will not experience such a transition. These transitional changes or respective lack thereof, is illustrated in Figure 8 by the sub-figures 4A and 4C.

Rotation of the panel 10 by a further 9.4° in a respective direction will make the numerals 1 and 5 visible on the lenticular system 14 (and will continue to do so for a further 9.4° of rotation in the same direction).

In a similar manner, the lenticular system 12 in the top and bottom representations, being sub-figures 5A and 5C respectively of figure 5, and the rest of the lenticular systems 14, 16 and 18, will function in the same way as described in respect of figure 4, when the panel 10 is rotated about an axis which is parallel to the direction of the lenticular columns of the lenticular system 12. In this rotational element the lenticular system 16 and 18 are expected to undergo some transitional change to their images, while the lenticular system 14 will not. These transitional changes or respective lack thereof, is illustrated in Figure 8 by the sub-figures 5A and 5C.

If the panel 10 in sub-figures 5A and 5C were rotated a further 9.4° in a respective direction, then the numerals 1 and 5 will be visible on the lenticular system 12, (and will continue to do so for a further 9.4° of rotation in the same direction).

In similar fashion, the lenticular system 16 in the bottom left and top right representations, being sub-figures 6A and 6C respectively of figure 6, and the other lenticular systems 12, 14 and 18, will function in much the same way as in figures 4 and 5, when the panel 10 is rotated about an axis which is parallel to the direction of the lenticular columns of the lenticular system 16. In this rotational element the lenticular system 12 and 14 are expected to undergo some transitional change to their images, while the lenticular system 18 will not. These transitional changes or respective lack thereof, is illustrated in Figure 8 by the sub-figures 6A and 6C.

If the panel 10 in sub-figures 6A and 6C were rotated a further 9.4° in a respective direction, then the letters A and D will be visible on the lenticular system 16 (and will continue to do so for a further 9.4° of rotation in the same direction).

In a similar manner, the lenticular system 18 in the top left and bottom right representations, being sub-figures 7A and 7C respectively of figure 7, and the other lenticular systems 12, 14 and 16, will function in much the same way as in figures 4, 5, and 6 when the panel 10 is rotated about an axis which is parallel to the direction of the lenticular columns of the lenticular system 18. In this rotational element the lenticular system 12 and 14 are expected to undergo some transitional change to their images, while the lenticular system 16 will not. These transitional changes or respective lack thereof, is illustrated in Figure 8 by the sub-figures 7A and 7C.

If the panel 10 in sub-figures 7A and 7C were rotated a further 9.4° in a respective direction, then the numerals 1 and 5 will be visible on the lenticular system 18 (and will continue to do so for a further 9.4° of rotation in the same direction).

As is mentioned above, the transitional changes mentioned in respect of figures 4 to 7 are illustrated in figure 8, wherein the rotation images, being the left and right representations (sub-figures 4A and 4C) of figure 4, top and bottom representations (sub-figures 5A and 5C) of figure 5, bottom left and top right representations (sub-figures 6A and 6C) of figure 6; and top left and bottom right representations (sub-figures 7A and 7C) of figure 7, are composited in figure 8.

It can be seen from the bottom left (sub-figure 6A) for example, that the lenticular systems 12 and 14 indicate "3-4" and "2-3" respectively, meaning that the image visible will be a combination of the numerals 3 and 4 and numerals 2 and 3 respectively.

By the array of possible combinations of images being stored in a look up table in a processing unit which will receive a signal of the images displayed from a digital camera, an unambiguous determination of the angle of the panel 10 to the digital camera will be identifiable.

In figure 9, the panel 10 of figure 1 is attached to a game controller 20, so that a digital camera 22 is able to receive the light reflected from the panel 10, and more particularly from the lenticular systems 12, 14, 16 and 18. By the digital camera seeing, sensing or reading the reflected light, an identification of the current visible signal received from the panel 10 can be made by a CPU 24, and then compared to a look up table or a logical progression of questions applied to the viewed data.

Figure 9 illustrates diagrammatically the eight angular orientations in the range of approx 4.7° to 14.1° away from the central perpendicular or 0 degree orientation, about each of four respective axes of rotation.

If desired, a panel 10 in the front of the controller 20 which is meant to face toward the camera 22 , as in figure 9, can be used in conjunction with a second panel 10 positioned on the controller 20 at a different angle to the panel 10 on the front. By then using a second camera, positioned at the side of the controller 20, a potentially more accurate assessment of the relative angle can be produced, by means of a cross checking system.

Lenticular systems have limits relating to maximal rotation, beyond which limits the image sequence contained therein will repeat. In the case of a columnar (hemi-cylindrical) lenticular array, repetition occurs at a rotation of approx 47 degrees. However it is possible to distinguish between the first lenticular image in a lenticular system and a repeat of that first lenticular image, if there are other lenticular systems such as in segments on the same panel surface as the first segment, but at different lenticule column orientations. If a first lenticular system has been rotated 47 degrees (and is thus repeating its image sequence), a second lenticular system which is oriented diagonally or at an angle to the first, will by virtue of its orientation only have been rotated half as much (in the case of a 45° angular displacement of the lenticule columns) around its own axis, and will therefore be only half way through its image sequence. By comparing the two lenticular mages displayed by the two lenticular systems, it

becomes possible to determine the angular rotation of the first lenticular system around its axis through a range beyond the maximal rotation limit of a single lenticular array.

In order for the object tracking software operating on the CPU to more readily identify the panel 10 and the lenticular systems 12, 14, 16 and 18, within the field of view of the camera, the panel 10 can be attached to or incorporated into a target, with a specific, pre-defined and unique shape or design, such as that illustrated in figure 14. The object tracking software can then be optimised to detect, and track the target and extract the visual information from the panel 10, and the lenticular systems 12 to 18, from the visual data collected by the camera.

The system described above has four lenticular systems 12,14,16 and 18. However a more limited range of angular measurement can be obtained by using a single lenticular system, such as any one of lenticular systems 12, 14, 16 or 18. A greater range of angular measurement can be obtained from two lenticular systems eg 12, 14, or 16, 18 etc if they are oriented at angles relative to each other. An even greater range of angular measurement will occur with more lenticular systems.

The system described above in relation to figures 1 to 9, can be made more accurate by providing more lenticular images in the lenticular image sequence, per lenticular system. The more lenticular images used in a lenticular image sequence in a lenticular system, the finer the angular detail that can be displayed. However, it should be noted that the more images that are used in a lenticular system, the more transitional or intermediate blending of consecutive lenticular images will occur. However with appropriate lenticular image design, transitional states can be useful, enabling the extraction of fractional angular data at finer increments than the number of lenticular images and the maximal rotation limit of the particular lenticular array would suggest. Lenticular systems or lenticular display panels can have up to 42 images therein, which will give better angular incrementation.

The above description utilises indicia such as letters and numerals for the lenticular images. However, if desired other systems can be utilised, such as coloured surfaces or colours, shapes, patterns, or symbols, or combinations of these.

Illustrated in figure 10 are nine sub figures all showing a composite panel 110 at 0°. Panel 110 is made up of twelve lenticular systems which form the segments which are composited. The segments are: two left side circumference segments 40 and 41, oriented at the same lenticular column angle; two right side circumference segments 42 and 43 oriented at the

same lenticular column angle as each other, but at 90° to the segments 40 and 41; two inner quadrants 44 and 45 being at the same angle but at 45° to both segments 40 and 42; two inner quadrants 46and 47 being at the same angle but at 90° to quadrants 44 and 45; two horizontal sections 48 and 49 being at the same angle, and two vertical sections 50 and 51, being at the same angle but at 90° to the sections 48 and 49.

The panel 110 is illustrated in figure 11, showing the patterns which would be visible at the angular orientations of figures 4A, 4C, 5A, 5C, 6A, 6C, 7A, and 7C, that is rotated by between 4.7° to 14.1° from the 0° orientation. However, as illustrated in figure 12, the same composite panel 110 at the same angular displacements as is illustrated in figure 11, attempts to show the transitional images, namely the grey portions.

Figure 13 is a simplified flow chart of the algorithm used to convert the images detected or sensed into angular orientation data.

While a look up table can be readily used, a logically progressing algorithm could be used instead.

The above description utilises reflected light from one or more lenticular systems on a panel. However, other multi-image systems can be used including holographic images, etched reflective surfaces, other reflective surfaces, images produced by transmission through the panels such as polarising filters, or by light generated from the panels, such as holographic panels..

While the above description has the panels and lenticular systems located on the moving object and the camera stationary, this can be reversed if desired and practical.

It will be understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text. All of these different combinations constitute various alternative aspects of the invention.

The foregoing describes embodiments of the present invention and modifications, obvious to those skilled in the art can be made thereto, without departing from the scope of the present invention.

CLAIMS:

1. An object orientation data collection system having:

   (a) at least one sensing means to detect and receive a visible light signal;

   (b) a pattern, indicia, colour or shape recognition processing means which receives signals from said at least one sensing means;

   (c) at least one light means corresponding to a respective one of said sensing means which generates, reflects or transmits visible light located remotely from but in line of sight to said sensing means;

   wherein said light means causes a pattern, indicia, colour or shape to be visible by said sensing means, said pattern, indicia, colour or shape which is sensed by said sensing means being caused to change when the relative angle between said sensing means and said light means is changed, whereby the change in pattern, indicia, colour or shape is processed by said processing means to identify the change in angle.

2. A system as claimed in claim 1, the change in angle is then communicated to a CPU for use in processing the change in orientation between the sensing means and the light means.

3. A system as claimed in any one of the preceding claims, wherein the sensing means is at an unmoving reference point.

4. A system as claimed in any one of the preceding claims, wherein the sensing means does not change its orientation relative to earth.

5. A system as claimed in claim 3 or 4, wherein said light means is positioned on an object the orientation of which is being sensed relative to said sensing means' orientation.

6. A system as claimed in any one of claims 1 or 2, wherein the light means is at an unmoving reference point.

7. A system as claimed in any one of the preceding claims, wherein the light means does not change its orientation relative to earth.

8. A system as claimed in claim 3 or 4, wherein said sensing means is positioned on an object the orientation of which is being sensed relative to said light means' orientation.

9. A system as claimed in any one of the preceding claims, wherein said light means produces a light signal by means of reflected and or transmitted light.

10. A system as claimed in claim 9, wherein said light means utilises one or a combination of one or more of the following: a holographic system, a lenticular system, a polarised filter system

11. A system as claimed in claim 10, wherein said holographic system, said lenticular system or said polarised filter system each has one or a sequence of more than one image associated therewith.

12. A system as claimed in any one of the preceding claims, wherein said light means is one or more lenticular systems.

13. A system as claimed in claim 12, wherein more than one lenticular system is utilised with a lenticular image viewable in said lenticular system when said lenticular system is viewed from different orientation.

14. A system as claimed in claim 12 or 13, wherein columnar lenticules are utilised in said lenticular system.

15. A system as claimed in claim 14, where multiple lenticular systems are used with the columnar direction of the lenticules of each respective lenticular system being at a different angle to each of the other lenticular systems.

16. A system as claimed in any one of the preceding claims wherein the light means is made up of a plurality of lenticular systems, with each lenticular system being located in substantially the same planar orientation.

17. A system as claimed in any one of claims 1 to 15, wherein the light means is made up of a plurality of lenticular systems, with one or more lenticular system being located in a different planar orientation to the rest of the lenticular systems.

18. A system as claimed in claim 17, wherein two lenticular systems are used with the angular spacing between the columnar lenticules on one lenticular system relative to the other lenticular system is 90°.

19. A system as claimed in claim 17, wherein three lenticular systems are used with the angular spacing between the columnar lenticules between respective lenticular systems is 120°.

20. A system as claimed in claim 17 wherein four lenticular panels are used with the angular spacing between the columnar lenticules of a first and second lenticular system is approximately 90°.

21. A system as claimed in claim 20, wherein the angular spacing a first set of first and second lenticular systems and the second set of first and second lenticular systems can be approximately 45°.

22. A systems as claimed in any one of the preceding claims wherein said light means is located within a distinctively shaped panel or border to form a target.

23. A system as claimed in any one of the preceding claims wherein said light means is such that when the light means is viewed from different angles, then an exhibited a pattern will change to a different pattern; or an exhibited indicia will change to a different indicia; or a exhibited colour will change to a different colour, or an exhibited shape will change to a different shape.

24. A system as claimed in any on eof claims 1 to 22, wherein said light means is such that when the light means is viewed from different angles, then an exhibited pattern will change to one or more than one of: an indicia, colour or shape; or an exhibited indicia will change to one or more than one of: a pattern, colour, shape; or an exhibited colour will change to one or more than one of: a pattern, indicia, shape; or an exhibited shape will change to one or more than one of: a pattern, indicia, colour.

25. A system as claimed in any one of the preceding claims wherein indicia can include letters, numbers, symbols or any appropriate machine recognisable image.

26. A system as claimed in any one of the preceding claims wherein said sensing means is a digital camera.

27. A system as claimed in any one of the preceding claims wherein there is only one sensing means and only one light means.

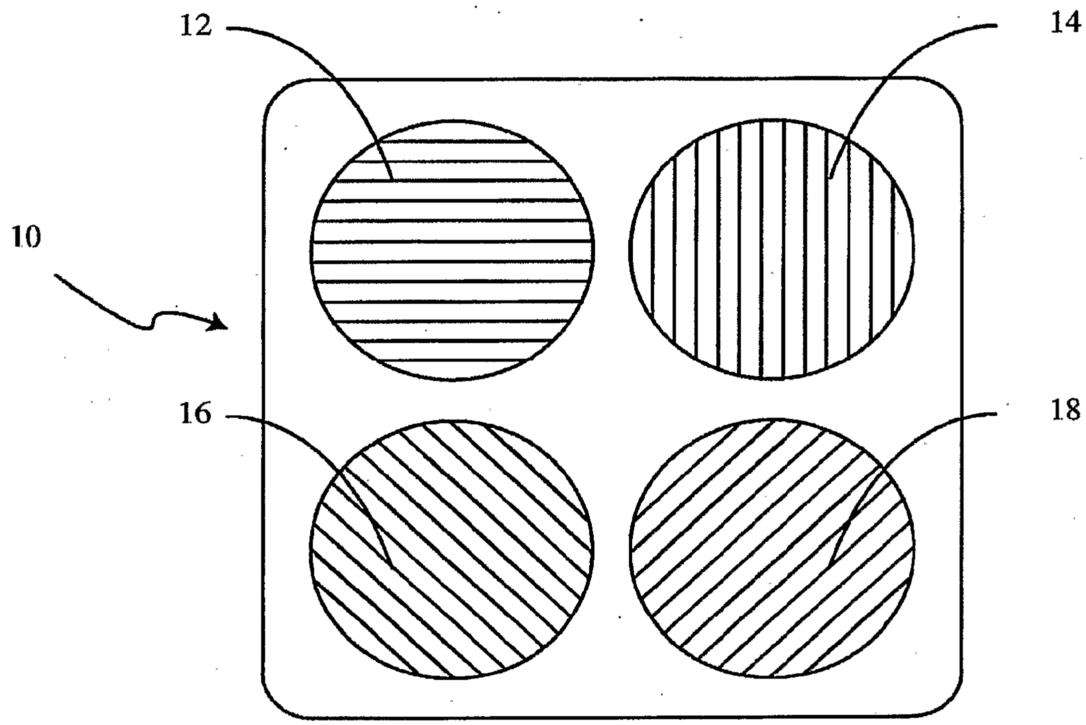
28. A system as claimed in any one of the preceding claims wherein said processing means operates to identify the angular orientation by one or more of the following: comparing the light or images sensed from said light means to a predefined table to determine orientation; processing by means of logical progression through an algorithm.

29. A system as claimed in any one of the preceding claims, wherein means is provided in said processing means, and said sensing means to calibrate a starting orientation of said light means to said sensing means.

30. A gaming system such as a computer based, console based, arcade based gaming system, wherein a system as claimed in any one of claims 1 to 28 is utilised to provide orientation data to a control system for said gaming system.

Dated this 8th Day of March
Daniel Barton
By his patent attorneys
HALFORD & CO

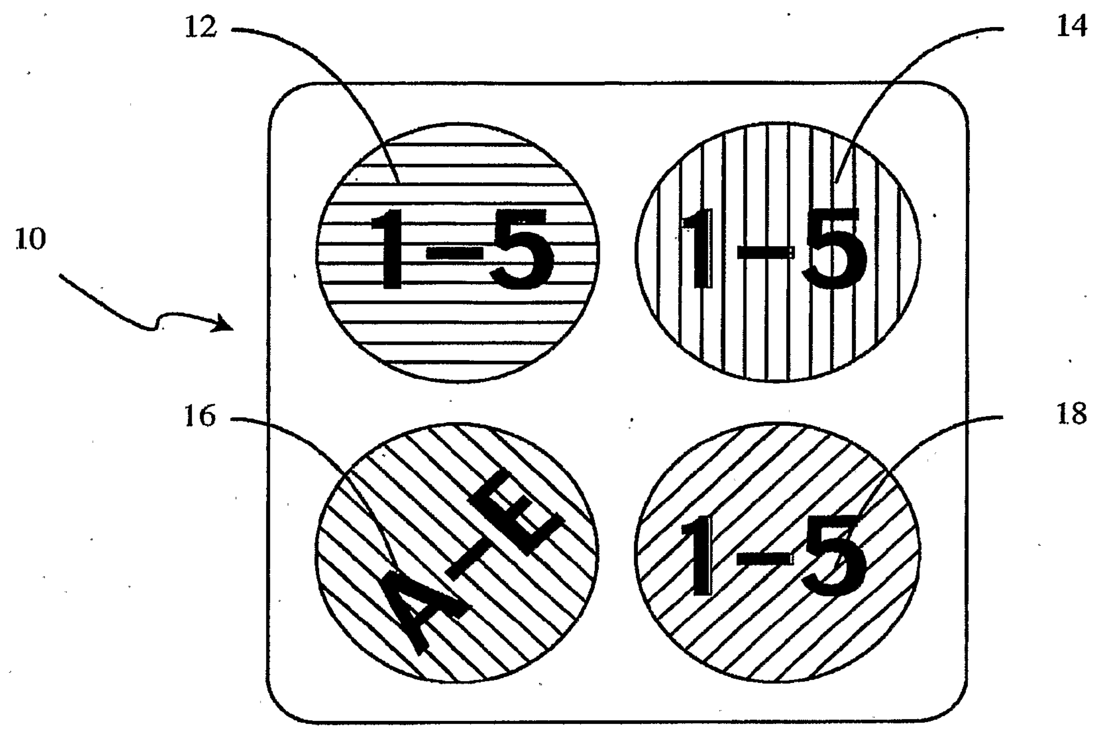
Figure 1



A target device made of a plurality of lenticular systesm attached to a panel & oriented in a variety of ways to enable rapid extraction of angular orientation of the target via a single optical sensor.

In this example, 4 sections of lenticular system are arranged such that they are oriented at 45˚ intervals from each other.

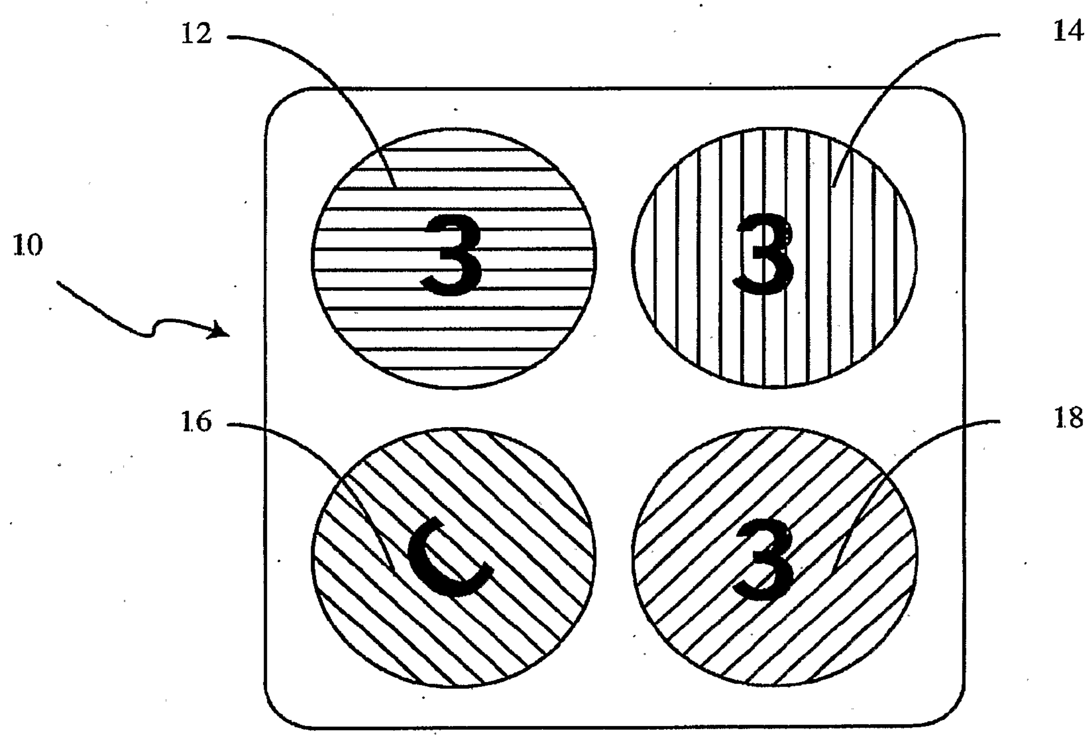
Figure 2



Each separate section of the lenticular composite target device displays one of a number of images depending on the angle in 3D space at which it is held with respect to the optical sensor.

In this example each lenticular element can display a total of 5 different images, depending on its orientation.

Figure 3



When the target is oriented at 0° to the sensor each lenticular component will show the middle image in its sequence of 5.

Figure 4

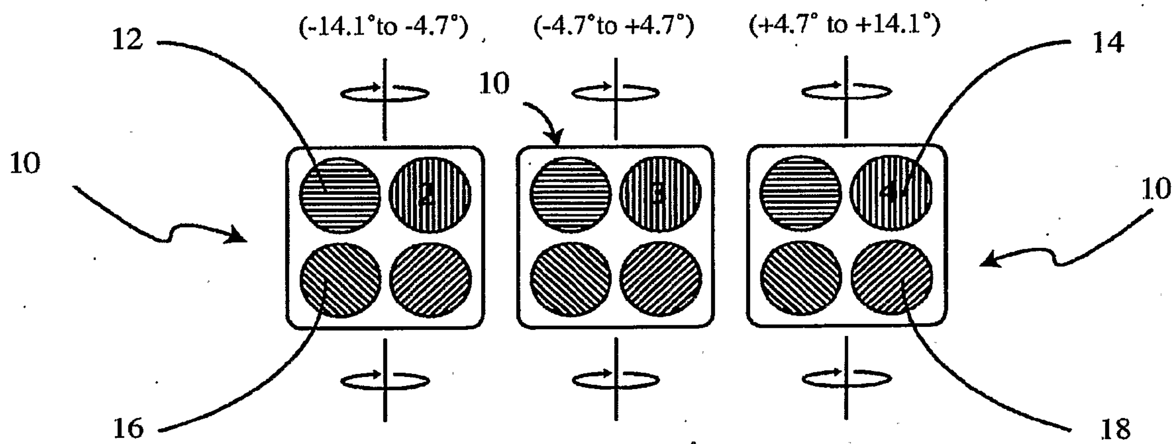
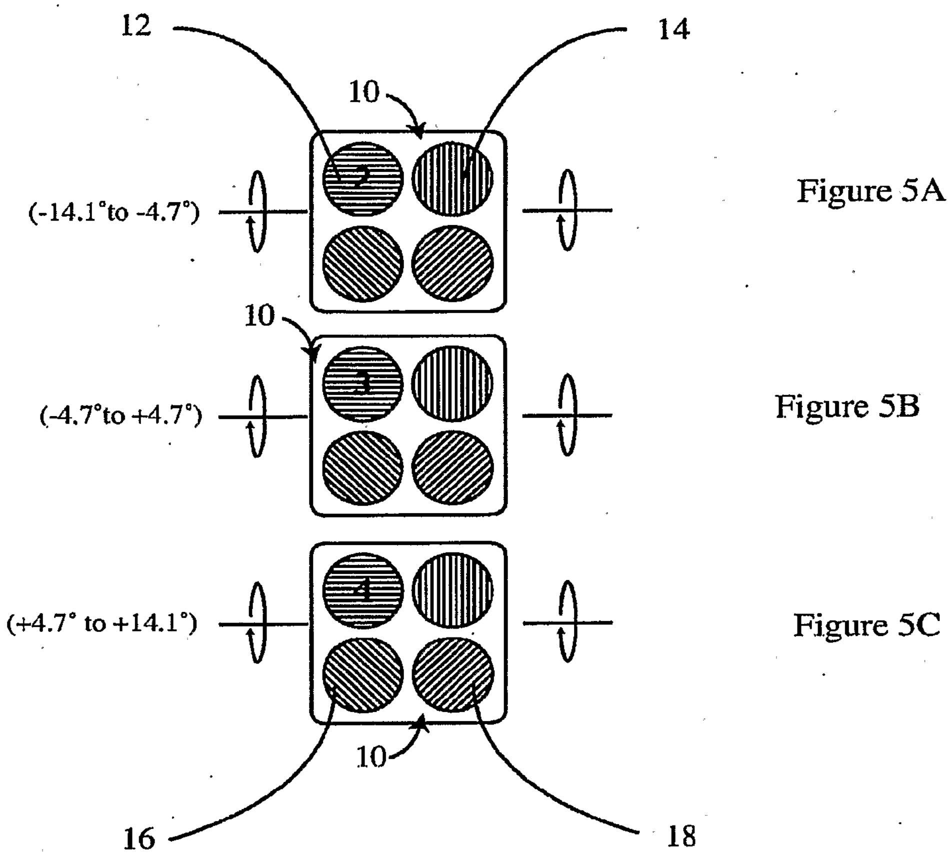


Figure 4A Figure 4B Figure 4C

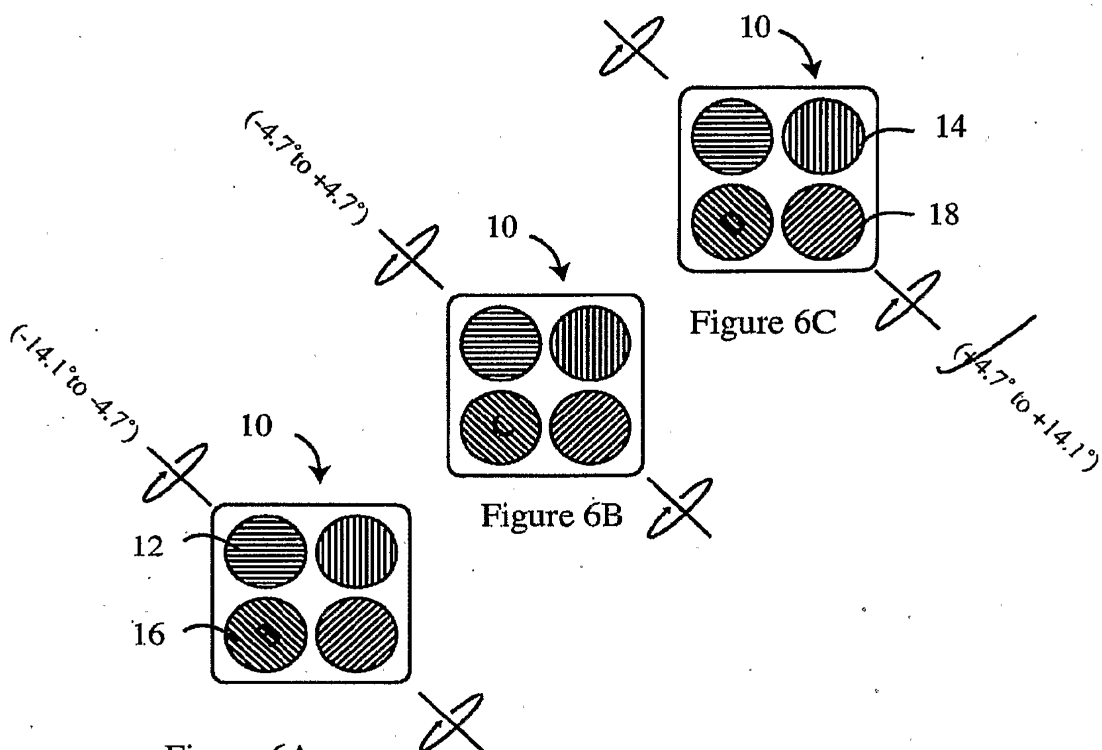
In this example the top right lenticular component of the target is oriented with its lenses vertical. As the target rotates around a vertical axis this component will show different images at predefined angles.

Figure 5



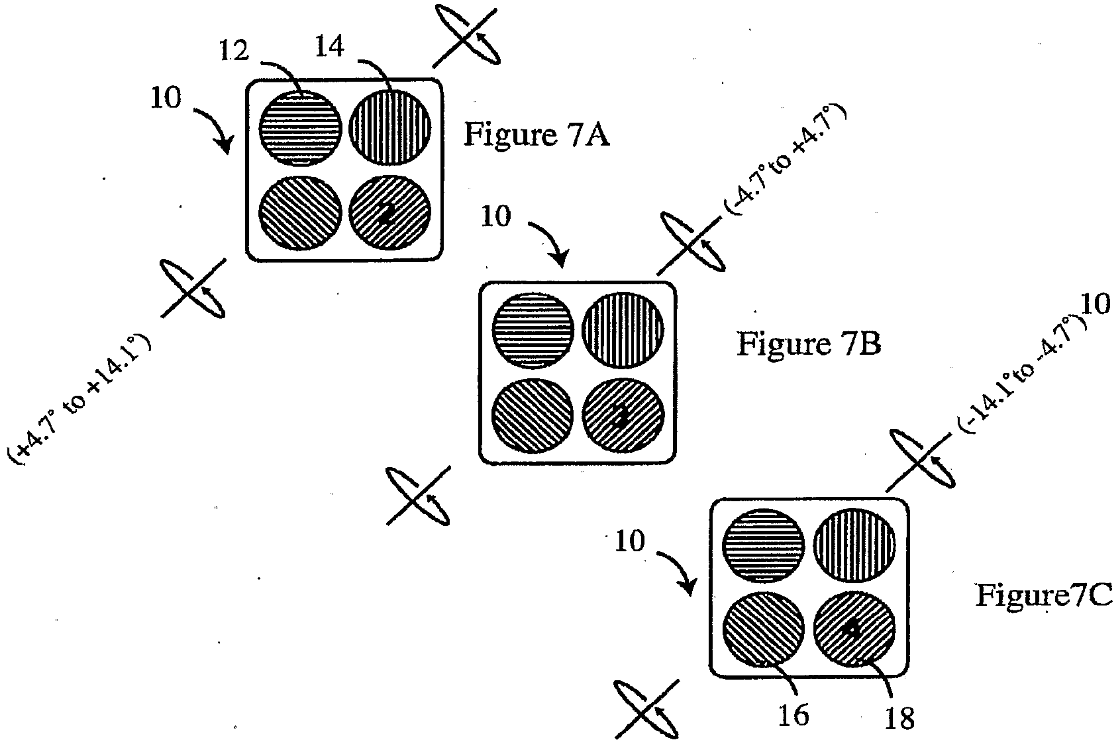
In this example the top left lenticular component of the target is oriented with its lenses horizontal. As the target rotates around a horizontal axis this component will show different images at predefined angles.

Figure 6



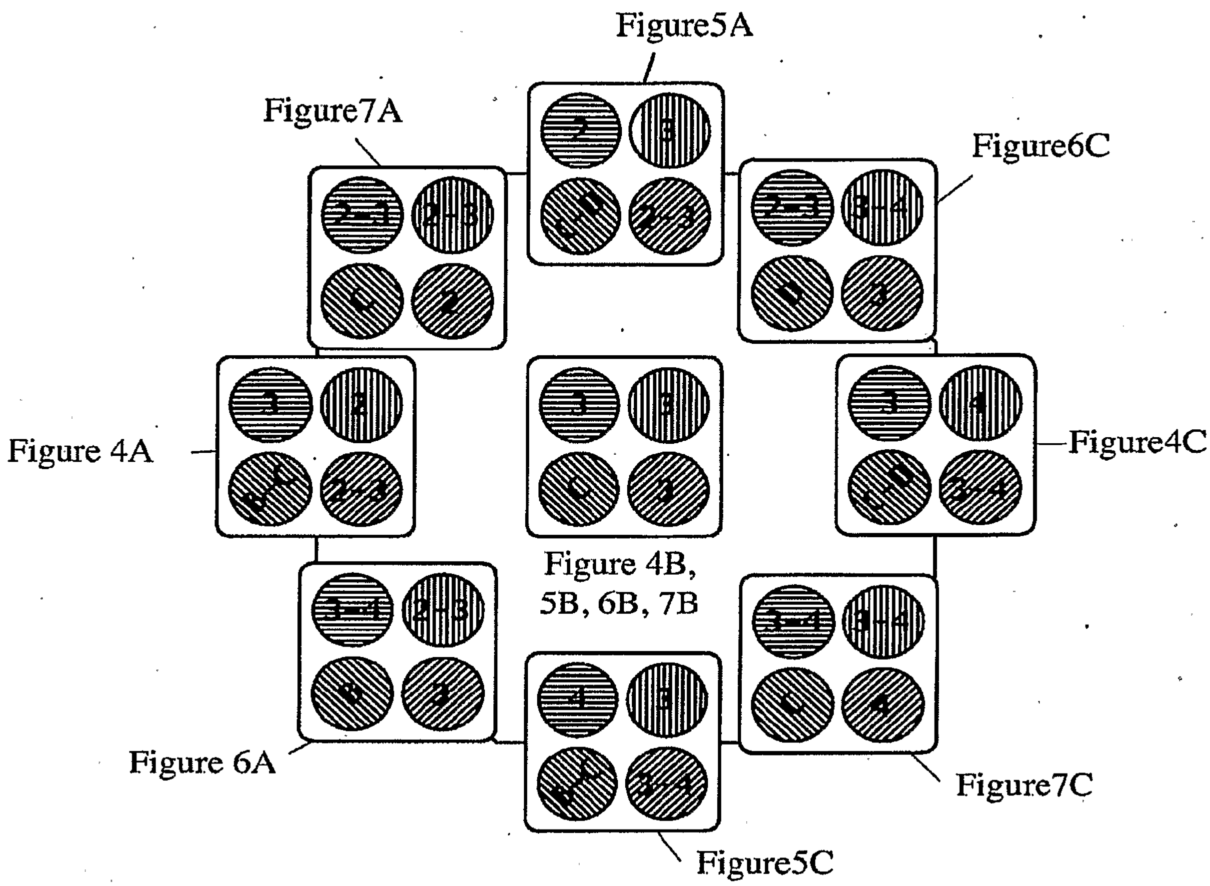
In this example the bottom left lenticular component of the target is oriented with its lenses diagonal (North West to South East). As the target rotates around the NW-SE axis, this component will show different images at predefined angles.

Figure 7



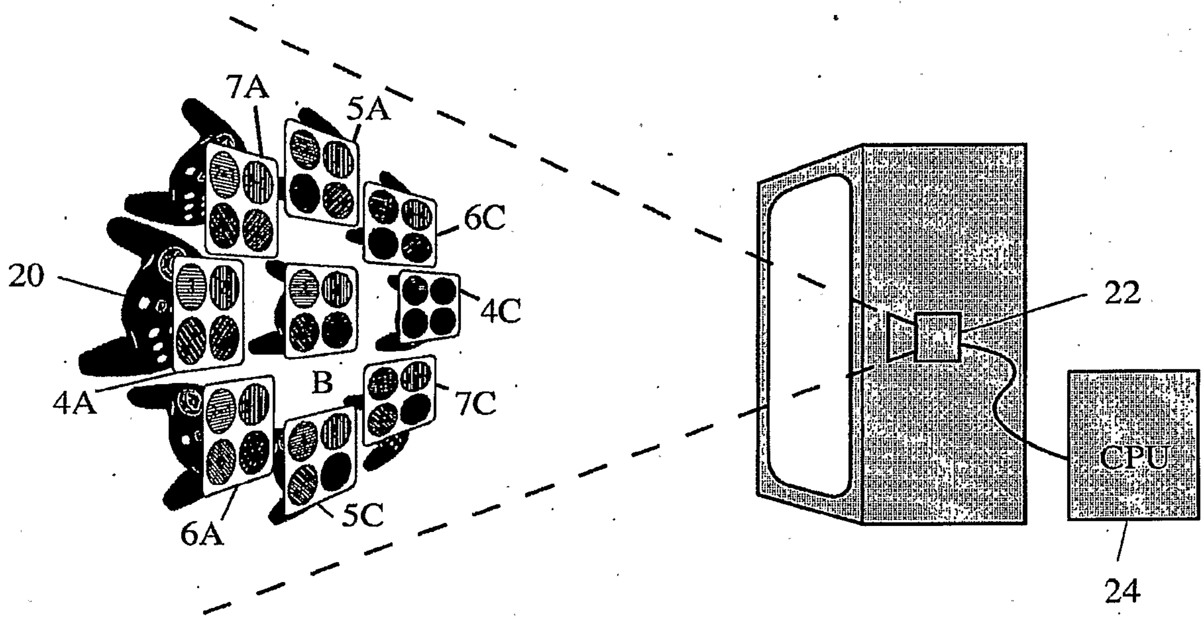
In this example the bottom right lenticular component of the target is oriented with its lenses diagonal (North East to South West). As the target rotates around the NE-SW axis, this component will show different images at predefined angles.

Figure 8



When all the lenticular components of the target are considered, the precise angular orientation in 3D space of the target can be determined by the combination of images which are displayed at any one time.

Figure 9



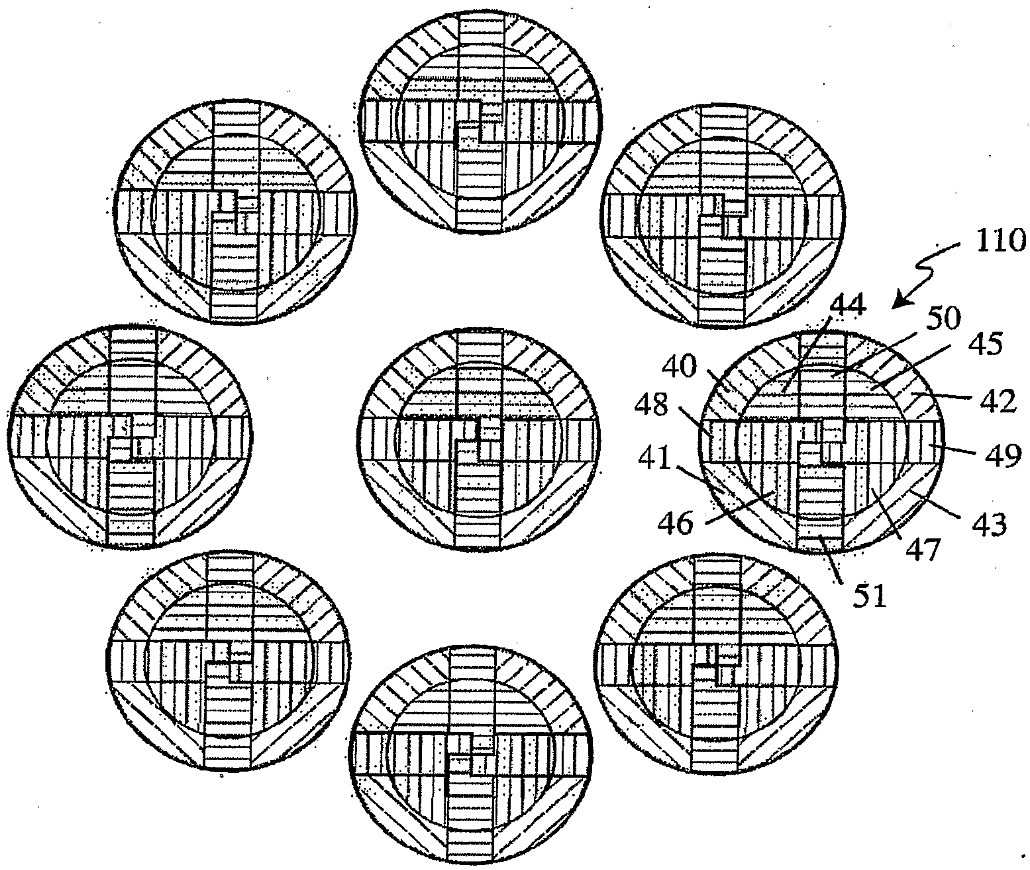
Example Use: Top view of a lenticular visual target being used in conjunction with a single optical sensor (camera) attached to a video game console or computer. Software analyses the combination of images displayed by the lenticular components of the visual target and determines the angular position at which a games controller is being held. Positional data is then used as game-control input.

The visual target can be attached to objects and a single optical sensor used to capture images of that object. The combination of images, colours or patterns shown by the different lenticular components enables rapid and unambiguous determination of the objects orientation in space, via computer analysis of the image and determination of the combination of images, colours or patterns that is visible.

Uses could include;

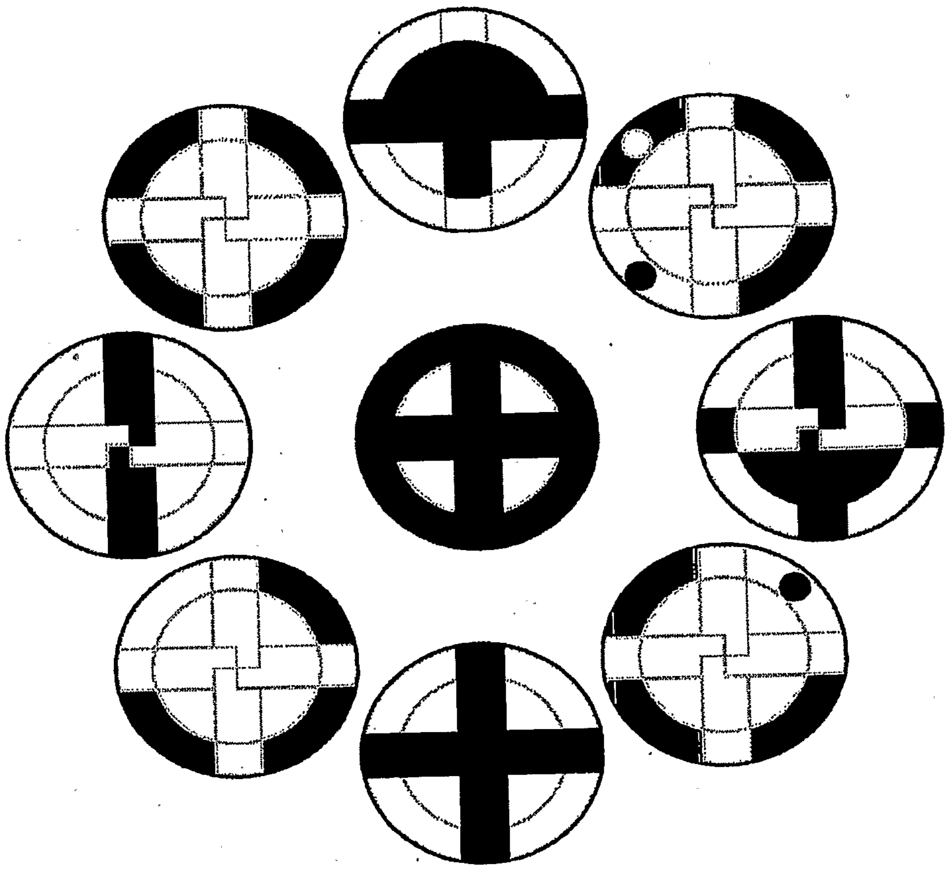
1. real-time games controller for video games with video camera attached
2. real-time detection of postion and orientation of components and elements in mechanical and robotic systems..

Figure 10



In this figure another example uses more complex arrangement of lenticular surfaces, with the intention of simplifying and optimising the image recognition task.

Figure 11



With appropriate images under each lenticular component of the target device, a unique symbol can be generated for each 3D angular position of the target.

In this example white and black elements indicate the image which would be displayed at that angle.

Figure 12

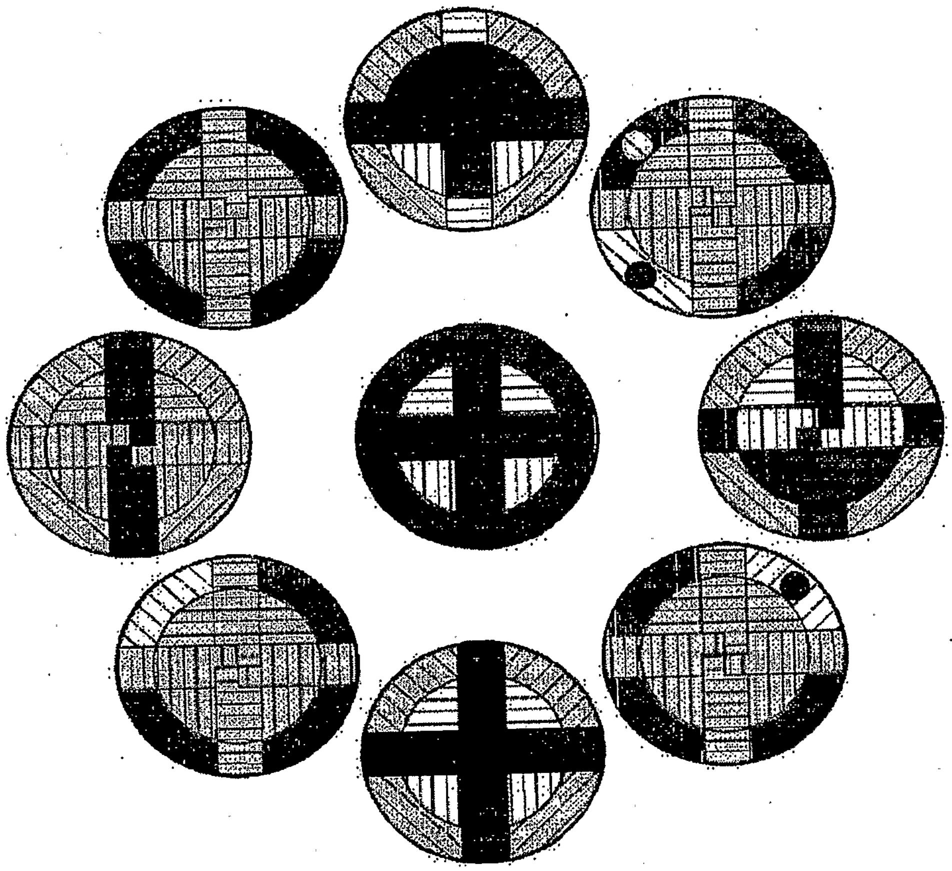
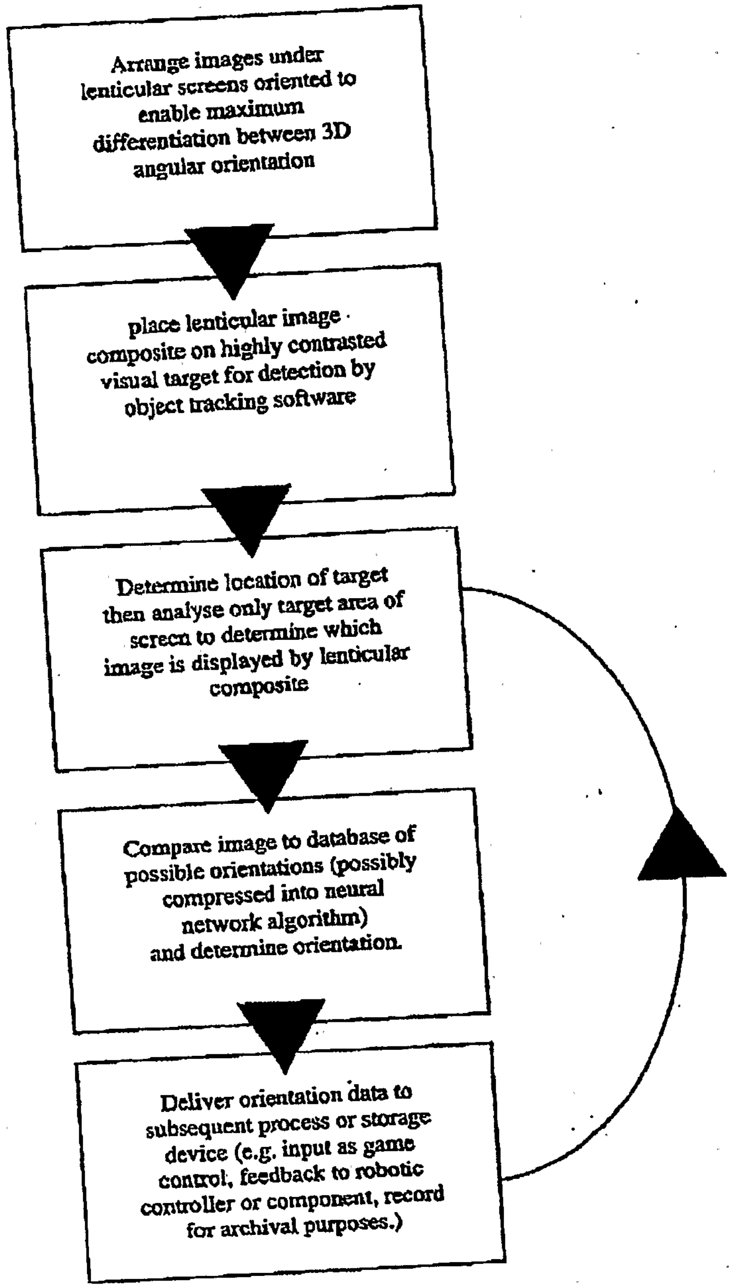


Figure 12 shows the lenticular orientation as well as the images to be displayed at each angular position. The light gray elements indicate those elements which may be at a transitional point at that position.

Figure 13


Arrange images under lenticular screens oriented to enable maximum differentiation between 3D angular orientation
place lenticular image composite on highly contrasted visual target for detection by object tracking software
Determine location of target then analyse only target area of screen to determine which image is displayed by lenticular composite
Compare image to database of possible orientations (possibly compressed into neural network algorithm) and determine orientation.
Deliver orientation data to subsequent process or storage device (e.g. input as game control, feedback to robotic controller or component, record for archival purposes.)

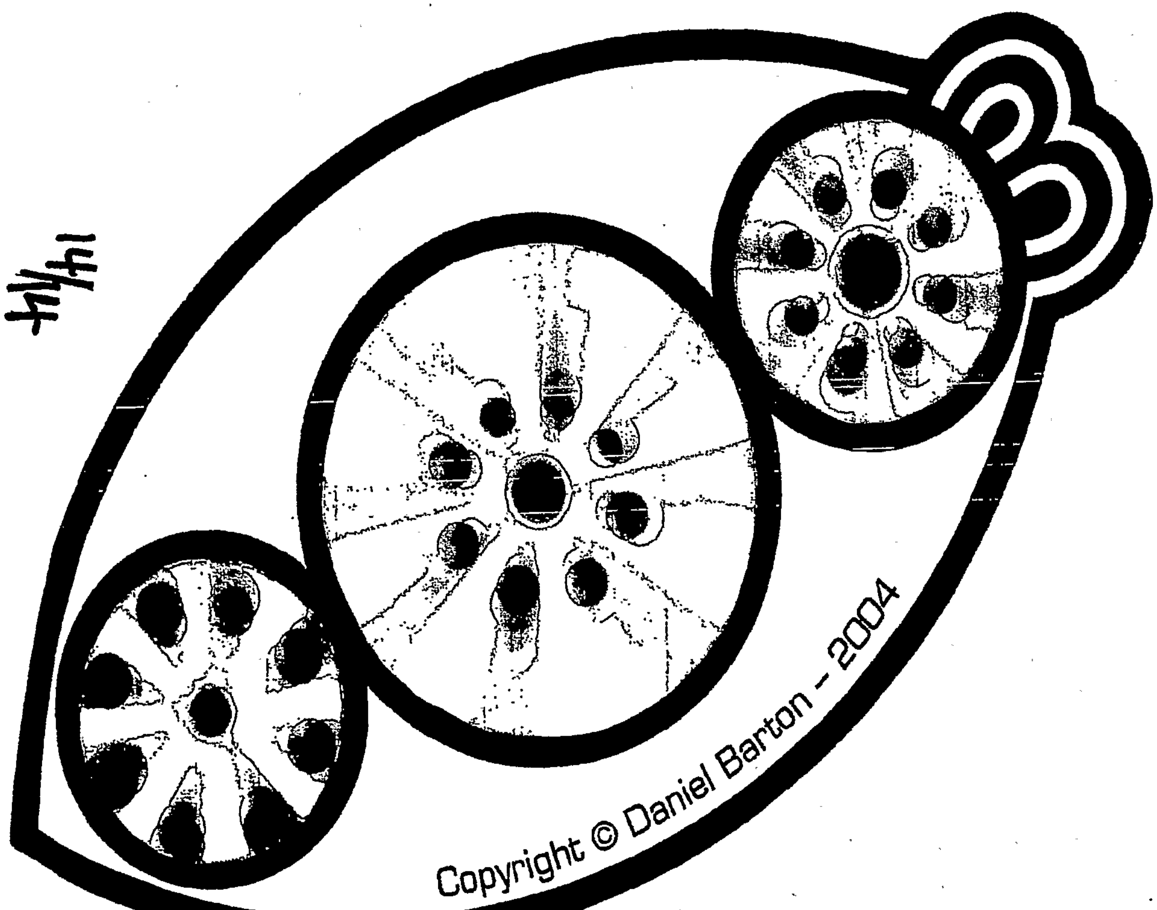


FIG 14